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MEMORANDUM

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SUBJECT: SUMMARY OF RESULTS FOR FISCAL YEAR 2002/03 GROUND WATER
PROTECTION LIST MONITORING FOR HEXAZINONE AND THREE OF
ITS DEGRADATES

SUMMARY

Hexazinone, including its degradation products, was chosen for monitoring from active ingredients on the Ground Water Protection List. Forty wells were sampled in eight counties during October 2002. Residues of hexazinone were detected in two wells in San Joaquin County. Three degradates of hexazinone were analyzed for but they were not detected. Nine wells contained residues of one or more other herbicides or herbicide degradates.

BACKGROUND

Sixty-two pesticide active ingredients (AIs) are currently on the Ground Water Protection List (Title 3, California Code of Regulations section 6800[b]), which is a list of AIs that have the potential to pollute ground water through normal agricultural use. From 1992 through 2002, a total of 23 AIs (1)(2)(3)(4)(5)(6)(7)(8)(9)(10) were monitored with 40 or more wells sampled for each. A revised monitoring protocol, approved in 1997 (11), is used to select AIs for monitoring based on information about their physico-chemical characteristics, cultural practices for crops on which they are applied, detections in ground water, and any other pertinent information.

The herbicide hexazinone, along with the degradates 2-hydroxycyclohexyl hexazinone, monomethyl hexazinone, and decyclohexyl-4-hydroxy hexazinone, was selected for monitoring during FY 2002/03.



METHODS

Wells were sampled during October 2002. Areas to be surveyed for sampling were selected based on Pesticide Use Report information for 1994-2000. Counties were listed in descending order for use of hexazinone, and the eight counties with the greatest use (pounds applied) were selected. Sections were chosen within each county where the greatest quantities of the pesticide had been applied. Areas containing clusters of high use sections were considered first. Those sections that had shallow depth to ground water were targeted as primary locations for monitoring. Sampling crews drove through pre-selected sections of land in each county with the goal of sampling one well per section. If no useable wells were found in a targeted section, attempts were made to locate a well in an adjacent section. For each well sampled, one primary sample, two backup samples and one field blank sample were collected.

The California Department of Food and Agriculture (CDFA) Laboratory performed analyses using a single analytical screen. Each well water sample was tested for hexazinone, 2-hydroxycyclohexyl hexazinone, monomethyl hexazinone, decyclohexyl-4-hydroxy hexazinone, atrazine, deethylatrazine (DEA), simazine, deisopropylatrazine (ACET), didealkylated triazine (DACT), prometon, bromacil, norflurazon, and diuron each with a reporting limit of 0.05 parts per billion.

Use of hexazinone was documented from Pesticide Use Reports for 1994-2000. The total number of pounds applied was determined for each section in which a well was sampled and also for the eight adjoining sections surrounding the monitored section. Land use characteristics were also determined for each section of land in which a well was sampled. The percentage of each land use type was determined based on 1994-1998 Department of Water Resources maps.

RESULTS

A total of 40 wells were sampled in eight counties and hexazinone was found in two wells in San Joaquin County (Table 1). No residues of any of the three hexazinone degradates were detected. Several wells contained residues of other herbicides including two wells in Glenn County, one in Madera County, one in Merced County, three in San Joaquin County, and two in Solano County. No herbicide residues were detected in any of the wells in Fresno County, Stanislaus County or Yolo County. Atrazine was found in 4 wells, simazine in 2, and diuron in 2 wells. Degradates of atrazine and simazine were also detected: DEA was detected in 5 wells, ACET was found in 4 wells and DACT in 3 wells.

The analytical method used by the CDFA laboratory is unequivocal for the 13 compounds included in the analytical screen; thus, no verification of those results is necessary.

Hexazinone use data and land use characteristics are presented by county in Tables 2-9. Each table contains the total number of pounds of hexazinone, atrazine, simazine and diuron applied during the years 1994-2000 for the section in which a well was sampled (in section) and also total use for that section plus the eight adjoining sections (9-section). Hexazinone was applied in both of the sections in San Joaquin County where its residue was detected.

DISCUSSION

In 1996, hexazinone was detected in wells in two adjacent sections monitored in San Joaquin County (12). These detections made in close proximity to each other satisfied one of the requirements for determining that the contamination resulted from legal agricultural use. Expanded monitoring was then conducted in the same area (13) and although no additional detections were made, hexazinone was entered into the AB2021 detection response process. A field investigation was conducted for possible point sources for the residues in ground water. During that investigation, agricultural drains and water collection pits located near the contaminated wells were examined as possible sources of hexazinone residues (14). No evidence was uncovered that the pits served as a point source for contamination of ground water. Although it was then concluded that the hexazinone detections in San Joaquin County were the result of legal agricultural use (15), a determination was made that the two detections should be considered transient and did not meet the criteria of being due to legal agricultural use (16).

Since 1996, the Environmental Hazards Assessment Program has detected hexazinone in several wells in six different counties, all located in the San Joaquin Valley or southern Sacramento Valley. The most recent detection was made in Solano County in April 2002. The presence of low concentrations of hexazinone in certain areas of California suggested that degradates of that pesticide might also be present in those areas or even in other areas of the state. This was found to be true for the triazine herbicides atrazine and simazine after the triazine degradates, deethylatrazine, deisopropylatrazine and didealkylated triazine were included in the analytical screen for ground water samples. One or more of these triazine degradates were found in numerous wells throughout the state. In contrast, hexazinone degradates were not detected in this study, even in wells where the parent was detected.

Two wells in San Joaquin County that contained hexazinone residues, were re-sampled during the current study. Residues were found in only one of the two wells. Furthermore, two wells that are part of a monitoring network in Fresno County, were found to contain hexazinone residues in March 2000 and 2001, respectively. When the wells were re-sampled up to 1 year later, no hexazinone residues were detected. Those results provide further evidence of the transient nature of some hexazinone contamination.

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Bob Rollins
March 12, 2003
Page 5

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15. Sanders, John S. March 28, 1997. Memorandum to Paul Gosselin: Agricultural use determination for hexazinone residues in ground water.
16. Gosselin, Paul H. August 1, 1997. Memorandum to John S. Sanders: Agricultural use determination for hexazinone residues in ground water.

Attachments

bcc: Weaver Surname File

Table 1. Detections of herbicides in wells sampled for hexazinone and three degradates during 2002-2003 Ground Water Protection List Monitoring. Only data for herbicides that were detected are presented ^a.

County	Township/Range-Section	Concentration, parts per billion						
		Hexazinone	Atrazine	Simazine	DEA	ACET	DACT	Diuron
Fresno	14S/16E-03	ND ^b	ND	ND	ND	ND	ND	ND
	14S/16E-08	ND	ND	ND	ND	ND	ND	ND
	14S/16E-09	ND	ND	ND	ND	ND	ND	ND
	15S/19E-03	ND	ND	ND	ND	ND	ND	ND
Glenn	21N/02W-02	ND	ND	ND	ND	ND	ND	ND
	21N/02W-03	ND	ND	ND	ND	ND	ND	ND
	21N/02W-14	ND	0.052	ND	0.076	ND	ND	ND
	21N/02W-23	ND	0.055	ND	0.063	ND	ND	ND
Madera	13S/16E-07	ND	ND	ND	ND	0.174	0.265	ND
Merced	08S/14E-09	ND	ND	ND	ND	ND	ND	ND
	08S/14E-15	ND	ND	ND	ND	ND	ND	ND
	08S/14E-34	ND	ND	ND	ND	ND	ND	0.06
	09S/09E-08	ND	ND	ND	ND	ND	ND	ND
	09S/14E-10	ND	ND	ND	ND	ND	ND	ND
	10S/10E-03	ND	ND	ND	ND	ND	ND	ND
San Joaquin	01N/06E-29	ND	ND	ND	ND	ND	ND	ND
	01N/08E-13	ND	ND	ND	ND	ND	ND	ND
	04N/05E-27	ND	ND	ND	ND	ND	ND	ND
	01S/06E-31	ND	ND	ND	ND	ND	ND	ND
	01S/07E-24	ND	ND	ND	ND	0.053	ND	0.075
	02S/04E-10	ND	ND	ND	ND	ND	ND	ND
	02S/04E-22	0.096	ND	0.05	0.079	ND	ND	ND
	02S/04E-25	ND	ND	0.098	ND	0.05	0.149	ND

Table 1. Continued.

County	Township/Range- Section	Concentration, parts per billion						
		Hexazinone	Atrazine	Simazine	DEA	ACET	DACT	Diuron
San Joaquin	02S/05E-12	ND	ND	ND	ND	ND	ND	ND
	02S/05E-23	ND	ND	ND	ND	ND	ND	ND
	02S/05E-24	0.05	ND	ND	ND	ND	ND	ND
Solano	06N/01E-13	ND	ND	ND	ND	ND	ND	ND
	06N/01E-22	ND	0.365	ND	0.07	ND	ND	ND
	06N/01E-23	ND	ND	ND	ND	ND	ND	ND
	07N/01E-20	ND	ND	ND	ND	ND	ND	ND
	07N/01E-32	ND	0.174	ND	0.306	0.06	0.05	ND
	07N/02E-19	ND	ND	ND	ND	ND	ND	ND
Stanislaus	03S/07E-11	ND	ND	ND	ND	ND	ND	ND
	04S/07E-22	ND	ND	ND	ND	ND	ND	ND
Yolo	09N/01E-26	ND	ND	ND	ND	ND	ND	ND
	09N/02E-22	ND	ND	ND	ND	ND	ND	ND
	09N/02E-28	ND	ND	ND	ND	ND	ND	ND
	09N/02E-34	ND	ND	ND	ND	ND	ND	ND
	10N/01W-27	ND	ND	ND	ND	ND	ND	ND
	10N/01W-36	ND	ND	ND	ND	ND	ND	ND

^a All samples were analyzed by the CDFA laboratory for hexazinone, 2-hydroxycyclohexyl hexazinone, monomethyl hexazinone, decyclohexyl-4-hydroxy hexazinone, atrazine, simazine, deethylatrazine (DEA), deisopropylatrazine (ACET), didealkylated triazine (DACT), prometon, bromacil, norflurazon and diuron.

^b ND = none detected at the reporting limit (RL) of 0.05 parts per billion for all chemicals. The RL is the smallest amount that can be reliably detected in a laboratory test and is set by the testing laboratory for each chemical.

Table 2. Fresno County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)										Right-of-Way Features Present (x)						
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Cotton	Corn	Misc. Field Crop	Grain & Hay	Onion & garlic	Alfalfa	Grapes	Native Vegetation	Dairy	Poultry Farm	Golf Course	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
15S/19E-03	603	1528	- ^d	-	1359	3649	-	-	45					40	8		8			X	X		X		X
14S/16E-03	-	745	-	-	10	1710	234	1102	31		4		3		19	15		3	25	X	X		X		X
14S/16E-08	-	1351	-	-	-	2692	-	558			10					86		4		X	X	X			X
14S/16E-09	-	1045	-	-	-	2402	-	792				50				50				X	X	X	X		X

^a Fresno Co. land use data obtained from 1994 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 3. Glenn County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)																Right-of-Way Features Present (x)						
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Oranges	Olives	Prune	Almond	Walnut	Safflower	Corn	Dry Beans	Sunflower	Grain & Hay	Idle	Pasture	Melon & Squash	Riparian	Farmstead	Dairy	Industrial	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
21N/02W-02	739	2253	955	1331	-	1002	-	98				33	5		25			7	1	27				2		X	X				X
21N/02W-03	380	2587	- ^d	2284	84	695	98	537	7	12	3	56	1			1					15		2		1	X	X		X		X
21N/02W-14	343	3092	-	376	291	1530	-	313		2		6			17			9		55	12					X	X				
21N/02W-23	1402	2468	-	-	321	907	278	471		4		26		6	14	21	6			13		4	1		4	X	X			X	X

^a Glenn Co. land use data obtained from 1998 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1995-2000 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1995-2000 in the monitored section plus the eight surrounding sections.

^d None applied for 1995-2000.

Table 4. Madera County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)			Right-of-Way Features Present (x)					
	^b In Section	^c 9-Section	^b In Section	^c 9-Section	^b In Section	^c 9-Section	^b In Section	^c 9-Section	Grain & Hay	Onion & garlic	Industrial - Warehouse	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
13S/16E-07	-	907	- ^d	-	25	1597	-	-	26	70	4	X	X				X

^a Madera Co. land use data obtained from 1995 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 5. Merced County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)										Right-of-Way Features Present (x)							
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Field Crop	Grain & Hay	Idle	Pasture	Rice	Native Vegetation	Water	Farmstead	Dairy Farms	Poultry Farm	Industrial	Residential	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
08S/14E-09	397	1614	- ^d	-	375	2330	-	-	31	9		52		1			6				X				X	X
08S/14E-15	244	1572	-	-	594	3671	-	-	25		1	64		1	1	3	6				X				X	X
08S/14E-34	48	1545	-	-	205	4728	-	-	23			22	9	36	4		6					X		X		
09S/09E-08	531	1241	-	-	1577	3668	-	571	23			76		1							X	X				X
09S/14E-10	416	2208	-	-	760	5143	-	191	7	25		38		24				6			X	X		X		
10S/10E-03	55	1229	-	-	280	3054	-	-	41	11		41				1	3		1	2	X	X				X

^a Merced Co. land use data obtained from 1994 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 6. San Joaquin County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)																		Right-of-Way Features Present (x)								
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Apple	Almond	Walnut	Safflower	Misc Field Crop	Corn	Dry Beans	Grain & Hay	Alfalfa	Misc. Pasture/ Turf Farm	Misc. Truck Crop	Tomato	Grapes	Native Vegetation	Water	Farmstead	Dairy/Feedlot	Poultry Farm	Urban	Idle / Vacant	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch	
04N/05E-27	204	946	53	159	-	663	636	2758						29		7	14					41	7			1				X	X				X
01N/08E-13	716	1664	-	-	786	5207	150	5045	23		31						6	11			10	17			1			1	2	X	X			X	
01N/06E-29	670	2316	-	-	2387	1296	-	2600				10	5	8				44	4		20		3	2	3	1		1		X	X			X	X
01S/06E-31	661	3035	-	-	1886	10644	38	992				1		13		37	34	4	9						1					X	X				X
01S/07E-24	552	1793	-	-	1234	3715	335	3178		34	6		6	14				21	1			6			2		4	4	3	X		X	X	X	X
02S/04E-10	389	1855	-	-	472	6982	-	-				7	2	32		21	17	11					1		2	3		1	4	X	X	X	X		X
02S/04E-22	625	1945	-	-	508	5509	-	-						5	6	1	54						1					29	4	X			X		X
02S/04E-25	445	2002	-	-	1341	6863	27	27				5		12	20	47	13	3					1							X	X		X		X
02S/05E-12	89	1225	-	-	428	5113	-	805						1	2	66	20	3		1		2	3	1						X	X		X		X
02S/05E-23	308	1983	-	-	2019	7185	-	14							9	7	55			19						2		1	6	X		X	X		X
02S/05E-24	248	1701	-	-	765	6536	-	-				14		1	7	31	28	1					1					13	3	X	X	X	X		X

^a San Joaquin Co. land use data obtained from 1996 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 7. Solano County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)												Right-of-Way Features Present (x)									
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Walnut	Misc. Field Crop	Corn	Sudan	Sugar Beets	Grain and Hay Crops	Alfalfa	Mixed Pasture	Misc. Truck Crop	Tomato	Native Vegetation	Water	Farmstead	Urban	Cemetery	Idle / Vacant	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
06N/01E-13	745	2422	- ^d	-	-	-	-	-	1	6	4			8	80					1					X	X				X
06N/01E-22	765	2688	-	-	-	-	-	-					25	5	66	1				3	1				X				X	X
06N/01E-23	429	3520	-	225	-	-	-	-		15				29	51	1				2	1		1		X				X	X
07N/01E-20	753	1633	-	-	384	976	-	97		18				17	29	19			6		8			3	X	X		X		X
07N/01E-32	609	1282	-	371	460	1352	-	-				26		36				24	8		1	5		1	X	X		X	X	X
07N/02E-19	240	1828	-	-	-	329	-	-			18			37	19		1	22			3				X	X				

^a Solano Co. land use data obtained from 1994 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 8. Stanislaus County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)										Right-of-Way Features Present (x)					
	In Section ^b	9-Section ^c	In Section	9-Section	In Section	9-Section	In Section	9-Section	Almond	Walnut	Corn	Dry Beans	Idle	Alfalfa	Tomato	Native Vegetation	Dairy	Urban	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
03S/07E-11	723	1353	- ^d	-	1412	2377	27	170	17	2		19	1	40	11	3		5	X	X		X		
04S/07E-22	513	1067	-	-	1137	2056	33	1151			96						4		X	X		X	X	

^a Stanislaus Co. land use data obtained from 1996 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.

Table 9. Yolo County - Use of hexazinone and selected herbicides and land use characteristics for sections of land in which wells were sampled for 2002 Ground Water Protection List monitoring.

Township/ Range- Section	Hexazinone Use		Atrazine Use		Diuron Use		Simazine Use		Land Use ^a (percentage of the section land area)														Right-of-Way Features Present (x)						
	^b In Section	^c 9-Section	In Section	9-Section	In Section	9-Section	In Section	9-Section	Com	Misc. Field Crop	Grain and Hay Crops	Alfalfa	Mixed Pasture	Misc. Truck Crop	Tomato	Riparian	Native Vegetation	Farmstead	Feedlot	Urban	Residential	Idle / Vacant	Railroad	Paved Road	Unpaved Road	Railroad Tracks	Other Rights of Way	Creeks	Canal/ Ditch
09N/01E-26	653	2647	- ^d	-	1164	4334	-	-	12		4	74	3				3	1		2		1		X	X			X	X
09N/02E-22	-	1712	-	-	-	1676	-	-	13		16			5	35		19				8	4		X			X	X	X
09N/02E-28	768	2041	-	-	1086	1794	-	-	22		28	29			9	5	2	1		1		2	1	X	X	X		X	X
09N/02E-34	511	1656	-	-	696	2189	-	-		10	22	25					26	1		3		12	1	X		X		X	X
10N/01W-27	791	1348	-	-	551	2013	-	-	13	7	11	39			12		1	1		5	5	7		X	X		X	X	X
10N/01W-36	658	2181	-	-	1036	6322	-	-	2		44	38			13			2	2					X	X		X	X	X

^a Yolo Co. land use data obtained from 1997 Department of Water Resources maps.

^b Total pounds of pesticide applied from 1994-1999 in the monitored section, where well was located.

^c Total pounds of pesticide applied from 1994-1999 in the monitored section plus the eight surrounding sections.

^d None applied for 1994-1999.